IN THE CLAIMS

Please amend claims 1-3 as follows (a marked-up copy of the claims is attached at the end of this Reply):

1. (Amended - Clean Copy) A method for laser drilling a hole in a multi-layered sheet-like material, the method comprising:

drilling the material by at least one laser pulse having a first energy, which generates an inter-layer pull-off force smaller than an inter-layer adhesion force of the multi-layered sheet; and

trimming a shape of the hole by at least one laser pulse having a second energy higher than the first energy, the first energy being within a range of approximately 1/7 to 7/25 of the second energy.

2. (Amended - Clean Copy) The method for laser drilling according to claim 1, further comprising controlling at least one of the first energy and the second energy by changing a laser pulse width.

3. (Amended - Clean Copy) The method for laser drilling according to claim 1, further comprising controlling at least one of the first energy and the second energy by changing a peak value.

Please enter the following claims for consideration:

---5. (New) A method for laser drilling a hole in a multi-layered sheet-like material, the method comprising:

drilling the material by at least one laser pulse having a first energy, which generates an inter-layer pull-off force smaller than an inter-layer adhesion force of the multi-layered sheet; and

trimming a shape of the hole by at least one laser pulse having a second energy higher than the first energy, the first energy being within a range of approximately 1/35 to 2/25 of the second energy.

6. (New) The method for laser drilling according to claim 5, further comprising controlling at least one of the first energy and the second energy by changing a laser pulse width.

7. (New) The method for laser drilling according to claim 5, further comprising controlling at least one of the first energy and the second energy by changing a laser pulse peak value.

8. (New) A method for laser drilling a hole, having at least one of a predetermined shape and size, through a material comprising a plurality of layers, the method comprising:

drilling an initial hole through the plurality of layers of the material using a first laser pulse train, the first laser pulse train comprising at least one laser pulse having a first energy

that generates an inter-layer pull-off force smaller than an inter-layer adhesion force between at least two of the plurality of layers; and

trimming the initial hole to the at least one of the predetermined shape and size of the hole, using a second laser pulse train comprising at least one laser pulse having a second energy, which is greater than the first energy.

9. (New) The method for laser drilling according to claim 8, wherein the second energy generates an inter-layer pull-off force greater than the inter-layer adhesion force between the at least two of the plurality of layers, the inter-layer pull-off force of the second energy being vented through the initial hole, preventing delamination of the at least two of the plurality of layers.

10. (New) The method for laser drilling according to claim 8, further comprising controlling at least one of the first energy and the second energy by changing a laser pulse width.

11. (New) The method for laser drilling according to claim 8, further comprising controlling at least one of the first energy and the second energy by changing a laser pulse peak value.---

## REMARKS

Upon entry of the present amendment, the title of the invention will have been changed from "A Method and Apparatus for Laser Drilling" to ---Laser Drilling---. Claims

1-3 will have been amended to correct cosmetic informalities in the claim language and to more clearly define the invention, while not substantially affecting or narrowing the scope of these claims. Claim 1 will have been further amended to include the relationship between the first energy and the second energy corresponding to the laser pulses. See, e.g., page 5, line 15.

Furthermore, upon entry of the present amendment, claims 5-11 will have been submitted for the Examiner's consideration. Claims 5-7 substantially correspond to claims 1-3, as amended, except that claim 5 includes a different relationship between the first energy and the second energy of the laser pulses. See, e.g., page 6, line 20. Independent claim 8 is directed to a laser drilling method in which an initial hole is drilled though all of the layers of a multi-layer material, prior to the final hole being trimmed at a high laser pulse energy. Claim 9 depends from claim 8, further defining the second energy as having an inter-layer pull-off force greater than the inter-layer adhesion force between at least two of the multiple layers of the material. Claims 10 and 11, which also depend from claim 8, are substantially the same as amended claims 2 and 3. Applicants respectfully submit that all pending claims are now in condition for allowance.

In the above-referenced Official Action, the Examiner noted Applicants' election with traverse to prosecute claims 1-3 and withdrew claim 4 from consideration. Applicants affirm

the election of claims 1-3 and respectfully traverse the same for at least the reasons set forth in the Response to Election Requirement, filed by Applicants on October 23, 2002.

With respect to patentability, the Examiner rejected claims 1-3 under 35 U.S.C. § 103(a) as being unpatentable over AYRTON (U.S. Patent No. 5,741,456) in view of ZAHAYKEVICH (International Publication No. WO 86/02301) in further view of TEMPLE et al. (U.S. Patent No. 6,228,311). The Examiner also rejected claims 1-3 under 35 U.S.C. § 103(a) as being unpatentable over WO 86/02301 in view of TEMPLE. Applicants respectfully traverse the rejections, at least for the reasons stated below.

The present invention is directed to preventing delamination of layers of a multi-layer, sheet-like material during the process of drilling holes through the material using laser pulses having different energies. More particularly, accordingly to the disclosed features of the present invention, an initial hole is drilled using a laser pulse (or series of laser pulses) with a pulse energy having an inter-layer pull-off force smaller than an inter-layer adhesion force of the multi-layered sheet, thereby preventing inter-layer delamination during the drilling process. Subsequently, the hole is trimmed using a laser pulse (or series of laser pulses) with a second pulse energy, having an inter-layer adhesion force greater than the first pulse energy, as well as greater than the inter-layer adhesion force of the multi-layered material (i.e., a pulse energy typically used to drill an appropriately sized through-hole in the material).

For example, referring to Figs. 2B and 3B, an initial hole is drilled with a pulse energy E2 and the subsequent trimming is performed using pulse energy E1, where E1 is the energy conventionally needed to drill the through-hole, as indicated in Figs. 2A and 3A. See page 5, line 14 - page 6, line 13. 14 - page 7, line 4. A significant advantage is that, although the hole is properly trimmed using the higher laser pulse energy, there is no inter-layer delamination due to excessive inter-layer pull-off forces.

With respect to the first rejection under 35 U.S.C. §103(a), the Examiner cites AYRTON in view of WO 86/02301 and TEMPLE. AYRTON is relevant to the present invention only to the extent that it teaches laser drilling. AYRTON does not recite the use of multiple pulses or pulse trains having different energies to prevent delamination during drilling. Although AYRTON mentions avoiding delamination, the inventors apparently credit the nature of the material, as opposed to the laser energy, for avoiding delamination. See, e.g., col. 3, line 41 - col. 4, line 5. In other words, there is no teaching that, with respect to the first laser pulse energy, the interlayer pull-off force of the pulses is smaller than an inter-layer adhesion force between material layers. The Examiner has improperly drawn a cause and effect conclusion with respect to AYRTON, apparently under an inherency argument, that the inventors themselves did not draw.

The Examiner asserts that it would be obvious to combine WO 86/02301 and AYRTON because both references solve "the similar problem of delamination of a multi-

layered sheet while drilling holes therein." However, there is no motivation to combine WO 86/02301 with AYRTON, insofar as each reference explicitly discloses that delamination is prevented, so there is no need to improve either reference, at least for purposes of preventing delamination. Likewise, there is no motivation to combine TEMPLE et al. with AYRTON or WO 86/02301. The Examiner relies on TEMPLE et al. to teach trimming a drilled hole in using a laser. However, TEMPLE et al. relates to drilling a hole in metal to form a nozzle, such as a nozzle in an ink jet print head, and does not appear to have any application to multiple layer materials or avoiding delamination.

Regardless of motivation, no proper combination of AYRTON, WO 86/02301 and TEMPLE teach or suggest the elements of the pending claims. Claims 1 and 5 respectively include ranges of ratios between the first laser pulse energy and the second (higher) laser pulse energy, which are not disclosed in any of the references. Claim 8 includes drilling an initial hole through all layers of the multiple layer material, prior to increasing the laser pulse energy and trimming the hole. In contrast, as relied upon by the Examiner, WO 86/02301 discloses using a low pulse power to drill through an initial metallic layer, which prevents delamination of the metallic layer, and using a higher pulse power to drill through an underlying insulating board layer. See, e.g., page 7, lines 5-6. There is no disclosure of using different energies of laser pulse trains to both drill a hole through the multi-layered material and to subsequently trim the through-hole at a higher power. Accordingly,

withdrawal of the rejections under 35 U.S.C., § 103(a) based on the combination of AYRTON, WO 86/02301 and TEMPLE is respectfully requested.

With respect to the second rejection under 35 U.S.C. §103(a), the Examiner cites WO 86/02301 in view of TEMPLE et al. Applicants respectfully submit that no proper combination of WO/02301 and TEMPLE et al. teach or suggest the conbination of elements of the present invention, as discussed above. Accordingly, withdrawal of the rejections under 35 U.S.C., § 103(a) based on the combination of WO 86/02301 and TEMPLE is respectfully requested.

With regard to claims 2-3, 6-7 and 9-11, Applicants assert that they are allowable at least because they depend from independent claims 1, 5 and 8, respectively, which the Applicants submit have been shown to be allowable.

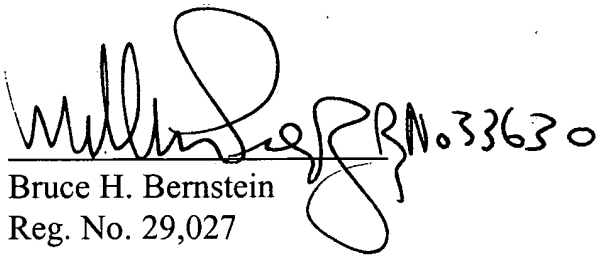
In view of the herein contained amendments and remarks, Applicants respectfully request reconsideration and withdrawal of previously asserted rejections set forth in the Official Action of November 4, 2002, together with an indication of the allowability of all pending claims, in due course. Such action is respectfully requested and is believed to be appropriate and proper.

Any amendments to the claims which have been made in this amendment, and which have not been specifically noted to overcome a rejection based upon the prior art, should be

considered to have been made for a purpose unrelated to patentability, and no estoppel should be deemed to attached thereto.

Should the Examiner have any questions concerning this Reply or the present application, the Examiner is respectfully requested to contact the undersigned at the telephone number listed below.

Respectfully submitted,
Izuru NAKAI et al.



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